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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to anti-friction bearing which is used, for example, is used for anti-friction bearing for transmission, other agricultural machines, construction machinery, steel machinery, etc. of a car in the contaminated oil containing the worn powder of a periphery article under severe conditions which are moreover called bottom of a semi-elevated temperature (120-200degreeC).

[0002]

[Description of the Prior Art]Most high-carbon-chromium bearing steel materials specified to Japanese Industrial Standard (JIS) G4805 have been used for the material used for the bearing for transmission of a car. Carburization and nitriding treatment were performed to this, compressive residual stress was given to the orbital surface, and improvement in a life in the contaminated oil containing worn powder was aimed at by raising hardness. For example, the invention indicated by JP,60-92463,A, Perform carbonitriding to high-carbon-chromium bearing steel, such as SUJ2, and a layer part is made to generate carbide (FeCr)<sub>3</sub>C, high hardness is given, abrasion resistance is raised, and the life under product tampering environment is raised by inducing compressive residual stress on the surface.

[0003]

[Problem(s) to be Solved by the Invention]Anti-friction bearing however, in the contaminated oil which contains worn powder even if a heavy load and improvement in the speed progress, an operating environment becomes cruel, it comes to be used under a semi- elevated temperature and it performs carburization and nitriding with the above-mentioned material, And when it is used under a semi- elevated temperature (120-200 \*\*), since tempering resistance is not enough, a raceway surface causes plastic deformation to the inside which is using the bearing for a long time, produces an indentation in it, and becomes the circumference with the

starting point of exfoliation generating in response to stress concentration in it. In abrasion resistance, it cannot say that it is enough, but during bearing use, change of the size by wear is produced and it becomes a cause of a short life.

[0004]

[Means for Solving the Problem]then, this invention is \*\* which made carbide  $(\text{FeCr})_7\text{C}_3$  far harder than  $(\text{FeCr})_3\text{C}$  generate by adding mostly to SUJ2 specified to JIS G4805, and carbonitriding Cr to it. This invention Namely, C:0.7 to 0.9 % of the weight, Cr:2.5-4.0 % of the weight, Carbonitriding processing of high carbon is performed in a depth of 0.3-0.5 mm to the surface of either one of a raceway surface of a bearing ring of anti-friction bearing produced from high-carbon-steel chromium bearing steel which consists of 0.8 ppm or less, the remainder iron Fe, and an inevitable impurity or a rolling contact surface of a rolling element, and its both sides, Furthermore, over the range of 0.05-0.15 mm, perform a grinding process and the layer part is removed, 15 to 30% and a size of those are 2 micrometers or less in a deviation-from-circular-form conversion diameter in an area rate about the amount of carbide in this surface, When hardness of this surface is HRC 63-65, and hardness of a core part is HRC 60-63 and the surface amount of retained austenites considers it as 10 - 25 capacity %, High hardness and abrasion resistance are given to the orbital surface, and tempering resistance is given, and anti-friction bearing which maintains a long life under a severe service condition is provided.

[0005]C content required in order to perform carburization and nitriding treatment, to make C concentration of a bearing layer part high and to obtain hardness of a bearing core part like the above is required for anti-friction bearing in this invention. There was an insoluble spheroidal carbide at carburization and nitriding temperature, this became a core, and since the amount of C for carbide generation required for a carbide deposit and the amount of C from which hardness of a 60 or more-HRC core part is obtained were required, a minimum of content of C was made into 0.7 % of the weight. When C content furthermore exceeds 0.9 % of the weight, a fall of having an adverse effect on plastic-working nature by generating of huge carbide in a material state and a rolling fatigue life will be caused. Then, C content was limited to 0.7 to 0.9%.

[0006]In order to promote carburization and nitriding, it combines with C and  $\text{M}_7\text{C}_3$  carbide is generated, it is hard, and in order that grain growth may be late, and fine dispersion of the Cr may be carried out and it may raise a rolling fatigue life, it is an effective element. Since there is little hard carbide according that content of Cr is less than 2.5% weight to carburization and nitriding hardening, HRC 63-65 is not obtained. If 4.0 % of the weight is exceeded, productivity will be since plastic-working nature is bad, falls at a high cost. Therefore, content of Cr was made into 2.5 to 4.0 % of the weight. In order for O to form nonmetallic inclusion of oxide stock

and to reduce a rolling fatigue life, it needs to reduce the quantity as much as possible. Therefore, 8 ppm was made into a maximum.

[0007]In order that the carbonitriding depth may set a minimum to 0.3 mm in order to leave a still more effective portion, even if it grinds, and it may shorten carbonitriding time, it sets the maximum to 0.5 mm. For removal of a fragile part of an anti-friction-bearing layer part, to remove at least 0.05 mm is required, and it is required for the amount of the maximum removal to be 0.15 mm for effective part survival. Since the amount of carbide on the surface of anti-friction bearing had an adverse effect on a life of a bearing when 15 to 30% of range was exceeded by an area rate, it limited to a mentioned range. Since a bearing life worsened also about particle diameter of carbide when this became large, the deviation-from-circular-form reduced property was 2 micrometers or less.

[0008]A test specimen including an example of this invention of an ingredient shown in Table 1 was ingoted, and each charge of a sample offering was heat-treated on conditions shown in Table 2. That is, nitriding [ C2 which is A1, A2, and a conventional example which are examples of an invention / carburized and ], respectively. \*\*\*\* hardening of the B and C1 which are examples of \*\*\*\*\* was carried out. Then, each charge of a sample offering was ground. 900 \*\*, 3-hour carburization, and nitriding treatment were performed with the degree of furnace temperature of RX gas + enrich gas (three to 5 capacity %) + ammonia gas (three to 5 capacity %), it tempered in an oil after that and annealing was performed at each temperature for 2 hours. It did not wait, but in \*\*\*\*\* it heated at 840 \*\* in RX gas atmosphere for 40 minutes, and it tempered in an oil after that.

[0009]Thus, in an example (A1, A2) of obtained this invention. It turns out that generate hard and detailed carbide  $M_3C + M_7C_3$  to a layer part, it excels in abrasion resistance be shown in Table 3 by the existence of C and Cr which dissolved to a matrix, and it excels also in heat resistance as shown in drawing 1. As furthermore shown in drawing 2, improvement in a rolling fatigue life in a product tampering oil is accepted. Since carbide very big and rough to a layer part and a vulnerable nitride arise by carburization and nitriding, a still longer lasting result is obtained like the example A2 of an invention by removing the portion by grinding.

[0010]It carried out to a wear test as a test condition using an Ogoe style quick abrasion tester by wear distance of 400 m, breaking load 6.3Kgf, and non-lubrication. Abrasion loss carried out with a wear rate of 0.61 m/sec showed a result of Table 3. In rolling fatigue life test, a life testing machine searched for an  $L_{10}$  life using a ball bearing life testing machine by Fujikoshi Corp. using the single row deep groove 6306. A test condition used a thing which bearing-loads load 830Kgf (radial load), bearing number of rotations of 3000 rpm, and a lubricating oil made mix hard iron powder whose particle diameter is 11-100 micrometers at a rate of 0.2g/1 into #80 gear-oil oil. Test temperature was performed at 120 \*\*.

[0011]

[Table 1]

供試材	C	Si	Mn	Cr	O	Fe	備考
A	0.81	0.23	0.31	3.23	6	残	発明例
B	1.01	0.25	0.28	1.35	12	残	比較例
C1	0.98	0.22	0.33	1.38	8	残	従来例
C2	0.98	0.22	0.33	1.38	8	残	従来例

注：各元素の含有量は重量％で示し、Oの含有量はppmで示す。

[0012]

[Table 2]

供試材	熱処理		研削量 mm	表面硬さ HRC	表層部の残留オーステナイト量%	表層部の酸化物の面積%	備考
	焼入	焼戻					
A1	浸炭焼化	220	0.02	63.0	2.7	2.0	発明例
A2	浸炭焼化	220	0.10	64.0	2.0	1.8	比較例
B	ずみ焼入	180	0.10	62.0	9	7	比較例
C1	ずみ焼入	180	0.10	62.0	9	7	比較例
C2	浸炭焼化	220	0.10	63.0	1.5	2.1	従来例

[0013]

[Table 3]

供試材	比摩耗量 $\times 10^3$ $\text{mm}^3/\text{kgf}$	寿命比	備考
A1	0.27	3.5	発明例
A2	0.35	5.0	
B	0.71	0.7	比較例
C1	0.41	2.5	
C2	0.73	1.0	従来例

[0013]

[Effect]Anti-friction bearing concerning this invention as mentioned above C:0.7 to 0.9 % of the weight, Cr : It is anti-friction bearing produced from the high-carbon-steel chromium bearing

steel which consists of O:8 ppm or less, the remainder iron Fe, and an inevitable impurity 2.5 to 4.0% of the weight, . Carbonitriding processing of high carbon should do to a depth of 0.3-0.5 mm on the surface of either one of the raceway surface of a bearing ring or rolling contact surface of a rolling element, and its both sides. Furthermore, the layer part is removed by the grinding process over the range which is 0.05-0.15 mm, As for the amount of carbide in this surface, 15 to 30% and the size of those are 2 micrometers or less in deviation-from-circular-form conversion diameter in an area rate, The hardness of this surface is HRC 63-65, and the hardness of a core part is HRC 60-63, Since the surface amount of retained austenites is ten to 25 capacity %, and an inner ring of spiral wound gasket or a rolling element, or the inclusion used as the starting point of a crack development is removed by both the inner ring of spiral wound gasket and the rolling element, moderate retained austenite is made to exist, and the minute crack development under lubricous of product tampering is prevented, and progress of the generated crack is delayed -- things can be carried out. As a result, in the bearing used under [ of product tampering ] lubricous, the life of a bearing can be raised compared with the conventional bearing under [ it is long lasting for whether your being Haruka, and / pure ] lubricous.

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[Translation done.]